User Note: Water Vapor Adsorption on Al_2O_3 at 293 K Using Static Volumetric Method

This experiment demonstrates the water vapor adsorption performance of the **Matrix 1000 system** using **γ-Al_2O_3** as a reference material under well-controlled conditions. The results illustrate the system's strong equilibrium control, stable low-pressure dosing, and capability for full isotherm characterization.

1. Experimental Summary

This water vapor adsorption isotherm test was conducted using the Matrix 1000 instrument. The adsorbate used was water vapor (H_2O), and the sample material was γ-Al_2O_3 with a mass of 0.0491 g. Prior to testing, the sample underwent degassing at 200 °C for 4 hours to ensure removal of any pre-adsorbed species. The analysis was performed at a constant temperature of 293 K using the static volumetric method. The total test duration was approximately 7 hours. The saturation vapor pressure (p_0) of water at this temperature, as measured during the test, was 3.169 kPa.

Parameter	Value
Instrument	Matrix 1000
Adsorbate	Water Vapor (H_2O)
Sample	γ-Al_2O_3
Sample Mass	0.0491 g
Degassing	200 °C for 4 hours
Temperature	293 K
Measurement Mode	Static Volumetric
Test Duration	~7 hours
p_0 (measured)	3.169 kPa

Table 1: Experimental Summary

ID	p (kPa)
1	0.0369
5	0.1431
10	0.4321
15	1.2677
20	1.9509
25	2.3914
30	2.7793
34	3.0078

Table 2: Truncated Isothermal (34 points total)

2. Isotherm Behavior

The isotherm spans **p/p_0 = 0.01 to 0.95** with a total of 34 points.

It exhibits characteristic **Type V adsorption behavior**, with limited uptake at low relative pressure, followed by rapid multilayer formation above p/p_0 = 0.6.

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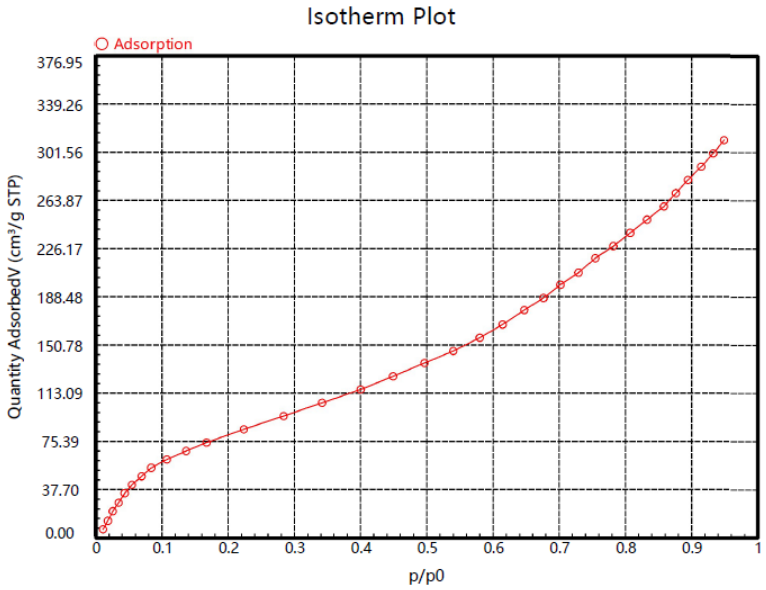

Figure 1. Water vapor adsorption isotherm (γ-Al_2O_3, 293 K). The curve shows a Type V profile, indicative of initial cluster formation followed by accelerated multilayer adsorption at higher relative pressures.

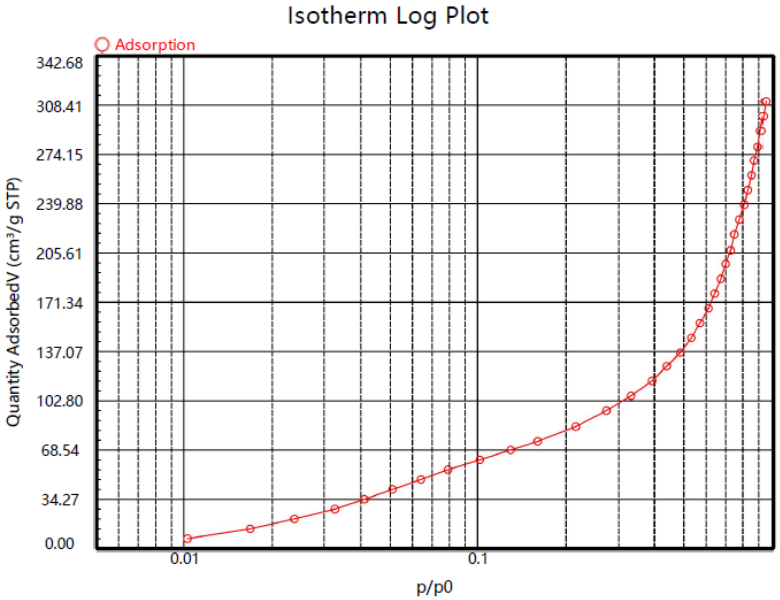

Figure 2. Log-scale isotherm plot highlighting the low-pressure region. The upward curvature confirms weak initial adsorption.

3. Dosing & Balance Control

To ensure reliable data acquisition, the system uses integrated built-in stability criteria to confirm equilibrium at each dosing point. These criteria are pressure-dependent:

- At **low pressures**, where minor fluctuations can significantly impact micropore data, the system enforces stricter stability thresholds before recording.
- At **higher pressures**, where the signal-to-noise ratio is greater, the stability requirement is relaxed to optimize measurement time without sacrificing accuracy.

As the system approaches a target pressure, it continuously monitors pressure change over a defined hold period. A point is only recorded when the pressure variation remains within the built-in threshold. These thresholds are pre-configured in the software for optimal performance, but parameters such as hold time can be adjusted by the user for specific applications.

Note: Water vapor has a relatively low saturation pressure (~3.17 kPa at 293 K), which can make stabilization slower and increase the potential for overshooting. In this experiment, the Matrix 1000 maintained stable dosing behavior across all points of the isotherm, including in the low-pressure region.

4. Saturation Vapor Pressure (p_0) Handling

- The saturation vapor pressure (p_0) is measured in real time using a dedicated pressure transducer.
- Alternatively, users may reference the built-in adsorbate properties table or consult the NIST Chemistry WebBook for literature values.

5. Conclusion

The Matrix 1000 successfully demonstrated precise water vapor dosing, segmented balance control, and accurate isotherm generation on γ-Al_2O_3 at ambient temperature. These results validate the system's effectiveness for analyzing microporous and hydrophilic samples.